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SEASONS IN MEDIUM-SIZED CITIES: A CALL FOR MORE PHENOLOGICAL DATA FROM THE TROPICS

ESTAÇÕES EM CIDADES DE PORTE MÉDIO: UM APELO POR MAIS DADOS FENOLÓGICOS DOS TRÓPICOS

ESTACIONES EN CIUDADES MEDIANAS: UN LLAMADO A MÁS DATOS FENOLÓGICOS DE LOS TRÓPICOS

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Abstract: Urban development is increasing across the Globe and having major impacts on the life histories of organisms, including their responses to the seasonality of the environment. Modified phenology is recognized as one of the more visible impacts of climate change, easy to study as well as to relate as a story to the public. Due to the location of the main academic centres, the main sources of data often come historically from the countryside, and more recently from metropolises and big cities in the Northern Hemisphere. However, for a better understanding of changes in seasonality at a global scale we recommend gathering more data from medium-sized towns and cities, especially in tropical regions.

Keywords: Seasonality, Climate Changes, Methods, Ecology, Birds, Plants.

Resumo: O desenvolvimento urbano aumenta em todo o mundo com grandes impactos nas histórias de vida dos organismos, incluindo suas respostas à sazonalidade ambiental. A fenologia modificada é reconhecida como um dos impactos mais visíveis das mudanças climáticas, fácil de estudar, bem como para ser relatada para o público. Devido à localização dos principais centros acadêmicos, as principais fontes de dados historicamente provêm do interior e, mais recentemente, das metrópoles e grandes cidades do hemisfério norte. No entanto, para uma melhor compreensão das mudanças na sazonalidade em escala global, recomendamos a obtenção de mais dados de cidades pequenas e de porte médio, especialmente em regiões tropicais.

Palavras-chave: sazonalidade, mudanças climáticas, métodos, ecologia, aves, plantas.

Resumen: El desarrollo urbano está aumentando en todo el mundo y tiene un gran impacto en las historias de vida de los organismos, incluidas sus respuestas a la estacionalidad ambiental. La fenología modificada es reconocida como uno de los impactos más visibles del cambio climático, fácil de estudiar y de relatarse para el público en general. Debido a la ubicación de los principales centros académicos, las principales fuentes de datos a menudo provienen del campo y, más recientemente, de las metrópolis y las grandes ciudades del hemisferio norte. Sin embargo, para una mejor comprensión de los cambios en la estacionalidad a escala global, recomendamos obtener más datos de pueblos y ciudades de tamaño mediano, especialmente en regiones tropicales.

Palabras clave: estacionalidad, cambios climáticos, métodos, ecología, aves, plantas.

INTRODUCTION

Urban development is increasing across the Globe and having major impacts not only on biodiversity but also on climate events themselves (SETO; GÜNERALP; HUTYRA, 2012; RUMBLE et al. 2019). For sustainability, responses to environmental pressures include a need to maintain synchrony within specific time windows. For example, among birds, the timing of migration and subsequent timing of reproduction may be critical (BIADUŃ; KITOWSKI; FILIPIUK, 2009; TRYJANOWSKI et al., 2011; HELM et al., 2013) and these have to change to match changes in temperature, vegetation development, and insect life-cycles, the main food sources of nestlings (HELM et al., 2013). These aspects are studied in phenology, which is the scientific discipline dedicated to the study of natural events, or of biological events, in relation to climate (SPARKS; MENZEL, 2002). Interestingly, changes in phenology are faster in urban than in rural areas (NEIL; WU, 2006; TRYJANOWSKI et al., 2013), because cities are characterized by higher temperatures than their surroundings and hence sometimes called 'heat islands'. Furthermore, it has recently been noted that global increases in temperature may be particularly strong in cities (NEIL; WU, 2006; SETO; GÜNERALP; HUTYRA, 2012). In the Northern Hemisphere, especially in Japan and Europe, phenology has a very long history and for particular cases, data stretch back to the eighth century (SPARKS; MENZEL, 2002). However, time-series from the Southern Hemisphere are much shorter. This can be crucial because urbanization processes are currently very fast in this part of the world (SETO; GÜNERALP; HUTYRA, 2012). Another point to consider is that the urban focus has mainly been on big metropolises, and small cities are ignored in many global analyses, including phenology and climate-related issues.

Therefore, we have the following aims in this opinion paper. Firstly, we try to characterize what is meant by medium-sized towns and cities, which is really not so trivial. Secondly, we link this knowledge to phenology and explain why it is important. Finally, we ask for more data on phenology, particularly from medium-sized towns and cities, and especially from the tropics where data and ecological publications are still underrepresented at the global scale (MARTIN; BLOSSEY; ELLIS, 2012). Although the authors of this opinion paper live and work in Europe, which has obviously impacted on our point of view, for example by the experience of the European situation, we believe that our more-or-less independent suggestions may be beneficial to future studies in other places, including Latin America.

SEARCHING FOR A DEFINITION

There is no single definition of 'medium-sized' with respect to towns and cities. The meaning depends on the scale one looks at. What appears medium-sized at a continental scale may be considered large at a national scale or even small at a global scale.

The classification was proposed by Dijkstra and Poelman (2012) based on an urban centre definition. An 'urban centre' is a new spatial concept based on high-density population grid cells and is not always the same as the administrative boundaries (e.g. Paris consists of many neighboring communes such as Neuilly-sur-Seine). They grouped sizes of the "urban centre" into six classes, depending on population:

- S - between 50,000 and 100,000
- M - between 100,000 and 250,000
- L - between 250,000 and 500,000
- XL - between 500,000 and 1,000,000
- XXL - between 1,000,000 and 5,000,000
- Global city - of more than 5,000,000

Both M and L categories can be considered 'medium-sized' at a European scale.

Cities/towns in OECD countries (2019) are classified as:

- Large metropolitan areas if they have a population of 1.5 million or more;
- Metropolitan areas if their population is between 500,000 and 1.5 million;
- Medium-size urban areas if their population is between 100,000 and 500,000;
- Small urban areas if their population is between 50,000 and 100,000.

A different view on the definition of a 'medium-sized' town/city is presented by Kunzmann (2010) that defines it as having a population of 20,000 to 200,000, depending on population density and the respective urban system of a country. He underlines that the shape and functions of these towns/cities depends strongly on location within the settlement structure: within larger metropolitan regions; on the edge of or between metropolitan regions; in the geographical periphery of Europe.

For the USA a 'medium-sized' town/city is usually defined (e.g. FULTON, 2002) as any town/city with a population of between 100,000 and 300,000 persons, located within a Metropolitan Statistical Area of 1 million persons or more.

DETERMINANTS OF URBAN SHAPE AND STRUCTURE

According to Benevolo (1980), until the end of the Renaissance, the shape of cities was generally determined by its defensive function. Since the palisades, city walls, and bastions had limited the available space, the ancient, Romanesque, Gothic or Renaissance city was characterized by narrow streets and a high density of buildings. The public spaces were usually limited to one square in the centre. There was no place for parks or other forms of green space. Cities were located along rivers or lakes to provide drinking water and transport of goods.

The development of artillery changed the emphasis on building city walls and bastions. As a consequence, the Baroque city could develop in a larger area. Usually, these cities developed around the palace of the founder (e.g. Karlsruhe or Mannheim). An important component was a palace park. Classicism added avenues planted with trees, squares and public parks to the urban structures. Since the Baroque period, the spatial development of cities was limited by access to transport. Initially, by the time needed to walk, then to ride by tram or railway and - since the beginning of the 20**th** century - also by private vehicle. The Industrial Revolution redefined the importance of greenery within built-up areas. The deteriorating conditions of the urban environment led to the development of parks or amenity forests. The provision of fruit and vegetables, as well as the need to counteract social unrest and revolution, prompted designers to create homes with gardens. This resulted in such ideas as Howard's Garden City or Soria-y-Mata's Linear City. Both concepts put stress on access to the private green space (gardens for planting fruit and vegetables) and public green areas within walking distance as places for rest and recreation. Ebenezer Howard's idealized garden city was designed to have about 32,000 inhabitants on a site of 2,400 ha. Several garden cities should be the satellites of a central city housing about 58,000 inhabitants. For him, the mid-sized towns ensured the best contact with nature and as well as the optimum population for economic and social development (HOWARD, 1902). Arturo Soria-y-Mata didn't set any limits for the number of inhabitants, but his cities should be mid-sized. The buildings could only occupy one-fifth of the land. Plots should be about 400m**2**: 80m**2** for the house and 320m**2** for the garden. This would be an extensive city of small isolated dwellings: to each family a house, in each house an orchard and a garden. In the 20**th** century, the European middle-sized towns and cities had usually lost both their agriculturally influenced economy and 'Fordist' mass production and were competing for new positions in the global economy. A clean environment and access to green areas are some of the competitiveness factors (HU 2015; SHEN; YANG, 2014). In highly developed countries, not only the availability of green areas but also the proper spatial structure of the settlement has had a significant impact on the quality of the environment. A well-designed urban structure reduces the demand for transport. Transport, especially a private vehicle, is usually the main source of air pollution and noise. The development of public transport and cycling infrastructure is therefore of key importance (BEIM; HAAG, 2011).

THE NAMES OF STREETS AND NATURE

Interaction between people and the seasonality of nature has impacted not only on research initiatives and citizen science programs but is also visible in daily life such as gardening (SPARKS et al., 2005; ANGEOLETTO; FELLOWES; SANTOS, 2018) or even more stable processes linked to place, for example, street names. Taking a general view, it is well known that in Europe and in the USA, there are various accepted practices for naming streets. A simple query (e.g. Straßenverzeichnis von Statistik Austria, Office for National Statistics UK or Krajowy Rejestr Urzędowy Podziału Terytorialnego Kraju) suggests that, in Europe, the streets (squares, avenues) – from the point of view of a particular city or town – are named after national heroes and people involved in national culture, political or social activities. Then there are the streets named after local geographical names (e.g. forest, fields, former settlements, villages, brooks, hills, etc.) or named after well-known cities, towns, regions or countries. Streets named after types of trees or other plants or animals are less common. However, at the scale of a whole country, and considering that in one village or town/city a particular name of street is allowed only once, names connected with land use or landscape ('Field St.', 'Forest St.'), physiognomy of street (e.g. 'Short St.', 'Long St.', 'Main St.'), public institutions (e.g. 'School St.', 'Station St.', 'Church St.') as well as streets named after types of trees (e.g. lime, birch, pine) are very popular.

The situation is radically different in the USA. Using statistics provided by The National League of Cities, the most common street names are numerals (e.g. 'First St.') and then names of the types of trees (oak, pine, maple, cedar, or elm).

Duany, Plater-Zyberk, and Speck (2001, p. 5-6) noted that a common practice in the USA was the construction of monofunctional – residential settlements. These are called housing subdivisions, also known as clusters or pods. "They are sometimes called villages, towns, and neighborhoods by their developers, which is misleading since those terms denote places which are not exclusively residential, and which provide an experiential richness not available in a housing tract. Subdivisions can be identified as such by their contrived names, which tend toward the romantic - Pheasant Mill Crossing - and often pay tribute to the natural or historic resource they have displaced". Similar rules are applied to other monofunctional districts of offices. They are called office parks or business parks. According to the above-mentioned authors these have roots in an idealistic vision of architecture and urban design. "Derived from the modernist architectural vision of the building standing free in the park, the contemporary office park is usually made of boxes in parking lots. Still imagined as a pastoral workplace isolated in nature, it has kept its idealistic name and also the quality of isolation, but in practice, it is more likely to be surrounded by highways than by countryside". A name associated with nature, regardless of whether residential or office district, has a positive commercial value. Dreams of contact with nature have a measurable economic dimension for developers.

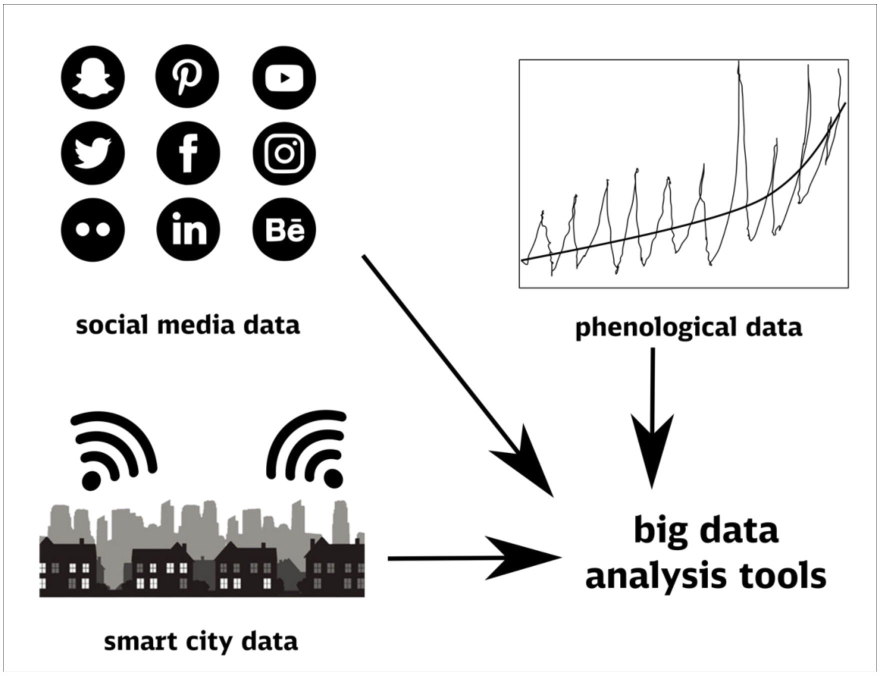
IDEAS FOR THE FUTURE

The value of phenological data has generally increased with time, and long-term studies must be promoted (SPARKS; MENZEL, 2002). However, taking the problem globally we have two problems; the biased temporal and spatial distributions of data. It is impossible to go back in time to ensure data at a good resolution, although some suggestions are provided, for example, to work with museum collections (BROOKS et al., 2014). Hence the most important thing is to focus on spatial distribution and to collect information in as many parts of the Globe as is possible. Many of the known phenological time series are based on one-person observation diaries, or single working teams (reviewed in SPARKS; MENZEL, 2002). New analysis suggests that phenology not only helps in understanding climate changes and their explanation to the general public but even simply a collection of information on flowering dates of plants and migration time of birds is very attractive for people, which can then be developed as citizen science projects (MAYER, 2010). Potentially it also has very practical applications, for example, to control alien and invasive species. For example, Visser et al. (2014), using the knowledge on plant phenology and access to the free and user-friendly software Google Earth, suggested the development of tools for gathering data on the distribution and abundance of invasive alien trees using visual interpretation. This then also helps in the early detection of emerging invasions, monitoring invasions over time, and helping researchers and managers identify suitable field study sites. Effective modeling of population dynamics at high spatial and temporal resolutions will have significant implications for city operations and policy, strategic long-term planning processes, emergency response and management, and public health.

Worldwide there is increasing access to smartphones with cameras, access to webcams, uploaded movies on video platforms (e.g. YouTube), and many others (Fig. 1). We suspect that these data sources will soon be available to study phenology using big-data solutions (KONTOKOSTA; JOHNSON, 2017). These showed how a real-time census of the city using Wi-Fi data collected in New York City's Lower Manhattan can be used to explore urban phenology as a function of localized population dynamics. Using Wi-Fi probe and connection data accounting for more than 20,000,000 data points for the year 2015 they presented a model to create real-time population estimates classified by residents, workers, and visitors/tourists in a given neighborhood and localized to a block or geolocation proximate to a Wi-Fi access point.

A huge change for the future could be the integration of phenology data and social media data with the data collected by cities or infrastructure managers within more and more popular urban big data systems (SCHWARTZ; UNGAR, 2015).

Figure 1. A scheme summarizing recent possibilities in phenological studies in cities.



Source: the authors.

We may only estimate how fast similar ideas will take to develop, even in the less well-developed parts of the world, but especially including small and medium-sized towns and cities, where citizens are looking for their own identity and for connections with living places and surrounding nature (EDWARDS; GOODWIN; WOODS, 2003).

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